MATHEMATICS STANDARDS OF LEARNING SAMPLE SCOPE AND SEQUENCE
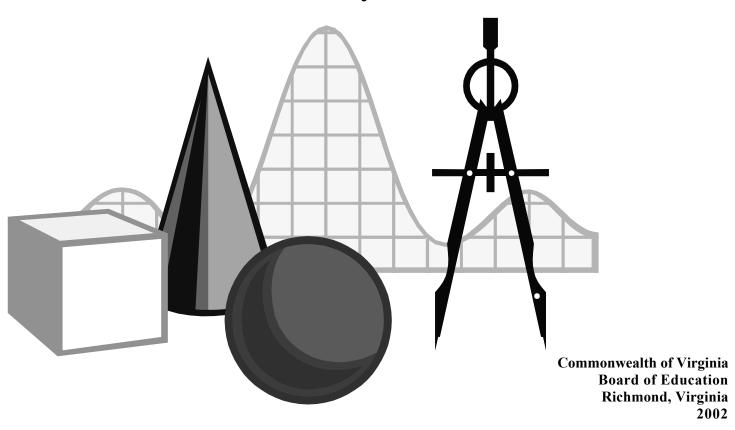
Geometry

Geometry Standards of Learning Sample Scope and Sequence

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NOTICE TO THE READER

The *Mathematics Standards of Learning Sample Scope and Sequence* and the *Mathematics Standards of Learning Teacher Resource Guide* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.pen.k12.va.us.

Geometry Standards of Learning Sample Scope and Sequence

Preface

As an additional resource to help school divisions develop curricula aligned to the 2001 Mathematics Standards of Learning, the Virginia Department of Education has developed sample scope and sequence documents in kindergarten through grade eight and in core high school courses. These sample documents provide guidance on how the essential knowledge and skills that are identified in the Standards of Learning and the Standards of Learning Curriculum Framework may be introduced to students in a logical, sequential, and meaningful manner.

These sample scope and sequence documents are intended to serve as general guides to help teachers and curriculum developers align their curricula and instruction to support the Standards of Learning. Each sample document is organized around specific topics to help teachers present information in an organized, articulated manner. Also included are correlations to the Standards of Learning for that curricular area for a particular grade level or course, as well as ideas for classroom assessments and teaching resources.

The sample scope and sequence documents are not intended to prescribe how curriculum should be developed or how instruction should be delivered. Instead, they provide examples showing how teachers and school divisions might present to students in a logical and effective manner information that has been aligned with the Standards of Learning. School divisions that need assistance in developing curricula aligned with the Standards of Learning are encouraged to consider the sample scope and sequence guides. Teachers who use the documents should correlate the content identified in the guides with available instructional resources and develop lesson plans to support instruction.

Copies of the sample scope and sequence guides are available at http://www.pen.k12.va.us in both PDF and Microsoft Word formats. These materials are copyrighted, and all rights are reserved. Reproduction of these materials for instructional purposes in Virginia classrooms is permitted.

Geometry Standards of Learning Sample Scope and Sequence

Introduction

Mathematics content develops sequentially in concert with a set of processes that are common to different bodies of mathematics knowledge. The content of the Mathematics Standards of Learning supports four process standards as goals for students: becoming mathematical problem solvers, communicating mathematically, reasoning mathematically, and making mathematical connections. These goals provide a context within which to develop the knowledge and skills identified in the standards.

Students should be helped to make connections and to build relationships between algebra, arithmetic, geometry, discrete mathematics, and probability and statistics. Connections should be made to other subject areas and fields of endeavor through applications. Using manipulatives, graphing calculators, and computer applications to develop concepts should help students develop and attach meaning to abstract ideas. Throughout the study of mathematics, students should be encouraged to talk about mathematics, to use the language and symbols of mathematics, to communicate, to discuss problems and problem solving, and to develop their competence and their confidence in themselves as mathematics students.

This document is intended as a general guide to help teachers and schools frame a curriculum that incorporates the fundamentals of secondary mathematics courses and to provide a correlation of those fundamentals to the Virginia Standards of Learning. It is organized around specific topics and includes correlations to the Mathematics Standards of Learning, as well as ideas for assessments and resources. This document is not intended as a script for either curriculum developers or instruction, but it will provide teachers and curriculum developers a place to begin building a curriculum.

This document serves as one of many mathematics resources available to all teachers in the Commonwealth of Virginia, including Algebra Instructional Modules, Geometry Instructional Modules, Connecting Algebra and Biology, Mathematics Standards of Learning for Virginia Public Schools, the Standards of Learning Test Blueprints, the Standards of Learning Test Released Items, and the Mathematics Standards of Learning Curriculum Framework.

Geometry Standards of Learning Sample Scope and Sequence

Overview of the Geometry Standards of Learning Sample Scope and Sequence

Organizing Topics	Related Standards of Learning
Reasoning and Proof	G.1
Lines and Angles	G.2, G.3, G.4, G.11
Triangles	G.2, G.5, G.6, G.7
Other Polygons	G.2, G.8, G.9, G.14
Circles	G.10
Three-Dimensional Geometry	G.12, G.13, G.14

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources

Reasoning and Proof	Use inductive reasoning to make conjectures.	G.1	Individual quizzes
			Group quizzes
			Tests
			Projects
			Investigations
			Portfolios
			Student presentations
			Questioning strategies
			Peer evaluation
				• Mathematics SOL Teacher Resource Guide
				http://www.pen.k12.va.us/VDOE/Instruction/math_resource.html
				• SOL Test Blueprints
				• SOL Test Released Items
				• The Geometry Center
				http://www.umn.edu/
				• NASA
				http://spacelink.nasa.gov/.index.html
				• The Math Forum
				http://forum.swarthmore.edu/
				• 4teachers
				http://www.4teachers.org
				• Appalachia Educational Laboratory (AEL)
				http://www.ael.org/pnp/index.htm
				• Eisenhower National Clearinghouse
				http://www.enc.org/
				• *Geometry Instructional Modules*
				  − Types of Proofs p. 41
				  − Venn Diagrams p. 46

	Write a conditional statement in if-then form.	G.1		
	Given a conditional statement, • identify the hypothesis and conclusion • write the converse, inverse, and contrapositive.	G.1		
	Translate short verbal arguments into symbolic form ($p \rightarrow q$ and $\sim p \rightarrow \sim q$).	G.1		
	Use valid logical arguments to prove or disprove conjectures.	G.1		
	Use the law of syllogism and the law of detachment in deductive arguments.	G.1		
	Diagram logical arguments involving quantifiers using Venn diagrams.	G.1		
	Solve linear equations and write them in if-then form (if $2x + 9 = 17$, then $x = 4$).	G.1		
	Justify each step in solving a linear equation with a field property of real numbers or a property of equality.	G.1		
	Present solving linear equations as a form of deductive proof.	G.1		

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Lines and Angles	Identify types of angle pairs: • complementary angles • supplementary angles • vertical angles • linear pairs of angles • alternate interior angles • consecutive interior angles • corresponding angles.	G.3	Individual quizzes Group quizzes Tests Projects Investigations Portfolios Student presentations Questioning strategies Peer evaluation	• Mathematics SOL Teacher Resource Guide http://www.pen.k12.va.us/VDOE/Instruction/math_resource.html • SOL Test Blueprints • SOL Test Released Items • The Geometry Center http://www.umn.edu/ • NASA http://spacelink.nasa.gov/.index.html • The Math Forum http://forum.swarthmore.edu/ • 4teachers http://www.4teachers.org • Appalachia Educational Laboratory (AEL) http://www.ael.org/pnp/index.htm • Eisenhower National Clearinghouse http://www.enc.org/
	Use inductive reasoning to determine the relationship between complementary angles, supplementary angles, vertical angles, and linear pairs of angles.	G.3		
	Define and identify parallel lines.	G.3		
	Find the slope of a line given the graph of the line, the equation of the line, or the coordinates of two points on the line. Investigate the relationship between the slopes of parallel lines.	G.2		
	Explore the relationship between alternate interior angles, consecutive interior angles, and corresponding angles when they occur as a result of parallel lines being cut by a transversal.	G.3		

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Lines and Angles (continued)	State these angle relationships as conditional statements.	G.3		• *Geometry Instructional Modules* – Exploring Vertical Angles p. 1 – Parallel Lines with Patty Paper p. 4 – Parallel Lines on the Graphing Calculator p. 6 – Angles and Parallel Lines p. 8 – Three Parallel Lines Investigation p. 12 – Constructing a Line Segment Congruent to a Given Line Segment p. 14 – Constructing the Bisector of a Line Segment p. 17 – Constructing a Perpendicular to a Given Line from a Point Not on the Line p. 24 – Constructing a Perpendicular to a Given Line at a Point on the Given Line p. 30 – Constructing the Bisector of a Given Angle p. 33 – Constructing an Angle Congruent to a Given Angle p. 38
	Solve practical problems involving these angle relationships.	G.3		
	Use the converses of the conditional statements about the angles associated with two parallel lines cut by a transversal to show necessary and sufficient conditions for parallel lines.	G.4		
	Verify the converses using deductive arguments, coordinate, and algebraic methods.	G.4		

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Lines and Angles (continued)	Using a compass and straightedge only, construct the following: • a line segment congruent to a given segment • an angle congruent to a given angle • the bisector of a given angle • a perpendicular to a given line from a point not on the given line • a perpendicular to a given line at a point on the given line.	G.11		
Triangles	Investigate and identify congruent figures.	G.5	Individual quizzes Group quizzes Tests Projects Investigations Portfolios Student presentations Questioning strategies Peer evaluation	• Mathematics SOL Teacher Resource Guide http://www.pen.k12.va.us/VDOE/Instruction/math_resource.html • SOL Test Blueprints • SOL Test Released Items • The Geometry Center http://www.umn.edu/ • NASA http://spacelink.nasa.gov/.index.html • The Math Forum http://forum.swarthmore.edu/
	Define congruent figures.	G.5		
	Map corresponding parts (angles and sides) of congruent figures onto each other.	G.5		
	Discuss applications of congruence such as rubber stamps, manufacturing, and patterns.	G.5		
	Understand the structure of Euclidean geometry: • undefined terms • defined terms • postulates • theorems.	G.5		

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources

Triangles (continued)	Verify that triangles are congruent using the following postulates:
	• side-angle-side (SAS)
	• angle-side-angle (ASA)
	• side-side-side (SSS)
	• angle-angle-side (AAS)
	• hypotenuse-leg (HL).
		G.5		• 4teachers http://www.4teachers.org
				• Appalachia Educational Laboratory (AEL) http://www.ael.org/pnp/index.htm
				• Eisenhower National Clearinghouse http://www.enc.org/
				• *Geometry Instructional Modules*
				  – Properties of Similar and Congruent Triangles p. 49
				  – Triangles and Midpoints p. 52
				  – Tangram Activity for Spatial Problem Solving p. 63
				  – How Many Triangles? p. 56

	Plan proofs.	G.5		
	Write deductive arguments as well as coordinate and algebraic demonstrations that triangles are congruent.	G.5		
	Use the definition of congruent triangles (corresponding parts of congruent triangles are congruent) to plan and write proofs.	G.5		
	Explore the constraints on the lengths of the sides of a triangle to develop the triangle inequality.	G.5		
	Use the triangle inequality to determine if three given segment lengths will form a triangle.	G.5		
	Explore the relationship between the angle measures in triangles and the lengths of the sides opposite those angles.	G.6		

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Triangles (continued)	Given side lengths in a triangle, identify the angles in order from largest to smallest or vice versa.	G.6		• *Geometry Instructional Modules* (continued) – Tangram Activities p. 58 – Geoboard Exploration of the Pythagorean Relationship p. 66 – Proofs of the Pythagorean Relationship p. 68 – Egyptian Rope Stretching p. 71 – Gulliver's Travels and Proportional Reasoning p. 145
	Given angle measures in a triangle, identify the sides in order from largest to smallest or vice versa.	G.6		
	Use indirect proof (proof by contradiction) to argue that all but one possible case in a given situation is impossible.	G.6		
	Use properties of proportions to solve practical problems.	G.6		
	Investigate and identify similar polygons.	G.6		
	Define similar polygons.	G.5		
	Use the following postulates to verify that triangles are similar. Deductive arguments as well as algebraic and coordinate methods may be used. • angle-angle (AA) • side-angle-side (SAS) • side-side-side (SSS)	G.5		
	Find the coordinates of the midpoint of a line segment.	G.2		

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Triangles (continued)	Verify the Pythagorean Theorem and its converse using deductive arguments as well as algebraic and coordinate methods.	G.7		
	Solve practical problems involving the Pythagorean Theorem and its converse. Use a calculator to find decimal approximations of solutions.	G.7		
	Use the Pythagorean Theorem to derive the distance formula.	G.2		
	Use the distance formula to find the length of line segments when given the coordinates of the endpoints.	G.2		
	Investigate the side lengths of isosceles right triangles and 30-60-90 triangles. Use inductive reasoning to conjecture about the relationships among the side lengths.	G.7		
	Use the properties of special right triangles to solve practical problems. Use a calculator to find decimal approximations of solutions.	G.7		
	Define sine, cosine, and tangent as trigonometric ratios in a right triangle.	G.7		
	Discuss exact values for trigonometric ratios and decimal approximations.	G.7		

Geometry Standards of Learning Sample Scope and Sequence

Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Triangles (continued)	Use right triangle trigonometry to solve right triangles.	G.7		
	Use right triangle trigonometry to solve practical problems. Use a calculator to find decimal approximations of solutions.	G.7		
Other Polygons	Identify, name, and classify polygons.	G.9	Individual quizzes Group quizzes Tests Projects Investigations Portfolios Student presentations Questioning strategies Peer evaluation	• Mathematics SOL Teacher Resource Guide http://www.pen.k12.va.us/VDOE/Instruction/math_resource.html • SOL Test Blueprints • SOL Test Released Items • The Geometry Center http://www.umn.edu/ • NASA http://spacelink.nasa.gov/.index.html • The Math Forum http://forum.swarthmore.edu/ • 4teachers http://www.4teachers.org • Appalachia Educational Laboratory (AEL) http://www.ael.org/pnp/index.htm
	Examine pre-image and image figures in the coordinate plane and determine whether a translation, reflection, or rotation has occurred.	G.2		
	Use inductive reasoning to develop a formula for finding the sum of the measures of the interior angles of a convex polygon and the measure of each interior angle of a regular polygon.	G.9		
	Investigate the sum of the measures of the exterior angles of any convex polygon and the measure of each exterior angle of a regular convex polygon.	G.9		
	Use tessellations and tiling problems to make connections to art, architecture, construction, and the sciences.	G.9		
	Investigate symmetry.	G.2		

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Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Other Polygons (continued)	Determine if a geometric figure has point symmetry, line symmetry, or no symmetry, and justify the conclusion.	G.2		• Eisenhower National Clearinghouse http://www.enc.org/ • *Geometry Instructional Modules* – Quadrilaterals and Their Properties p.72 – Quadrilateral Properties Laboratory p. 76 – Quadrilateral Sorting Laboratory p. 80 – Transformations and Congruence p. 54 – Quadrilateral Diagonal Investigation p. 84 – Triangle and Quadrilateral Angle Laboratory p. 89 – The Sum of the Angles in a Polygon p. 94 – Interior Angles in Polygon p. 99
	Define parallelogram.	G.8		
	Use inductive reasoning to make conjectures about the properties of parallelograms.	G.8		
	Prove the properties of parallelograms using deductive arguments as well as algebraic or coordinate methods.	G.8		
	Verify the converses of the properties of parallelograms and use the converses to prove that a quadrilateral is a parallelogram. Coordinate methods may involve using slope to show that lines are parallel or perpendicular.	G.8		
	Identify rhombi, squares, and rectangles as special parallelograms and prove their properties using deductive arguments as well as algebraic and coordinate methods.	G.8		
	Identify trapezoids and isosceles trapezoids. Prove their properties using deductive arguments as well as algebraic and coordinate methods.	G.8		

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Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Other Polygons (continued)	Identify kites and prove their properties using deductive arguments as well as algebraic and coordinate methods.	G.8		
	Use the properties of parallelograms and other quadrilaterals to solve practical problems.	G.8		
	Given the areas of similar geometric figures, investigate the effect on the constant of proportionality of changing one dimension (multiplying by a constant).	G.14		
	Generalize the change and use the generalization to solve practical problems.	G.14		

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Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Circles	Define the term circle. Differentiate between a circle and a circular region.	G.10	Individual quizzes Group quizzes Tests Projects Investigations Portfolios Student presentations Questioning strategies Peer evaluation	• Mathematics SOL Teacher Resource Guide http://www.pen.k12.va.us/VDOE/Instruction/math_resource.html • SOL Test Blueprints • SOL Test Released Items • The Geometry Center http://www.umn.edu/ • NASA http://spacelink.nasa.gov/.index.html • The Math Forum http://forum.swarthmore.edu/ • 4teachers http://www.4teachers.org • Appalachia Educational Laboratory (AEL) http://www.ael.org/pnp/index.htm • Eisenhower National Clearinghouse http://www.enc.org/
	Use the vocabulary associated with circles.	G.10		
	Describe ways that circles intersect.	G.10		
	Explore and state properties of tangents.	G.10		
	Measure central angles, inscribed angles, and arcs of circles directly and indirectly. Generalize the relationship between angle measure and arc measure.	G.10		
	Investigate properties of chords and arcs of circles.	G.10		
	Measure angles formed by tangents, chords, and secants directly and indirectly. Generalize the relationship between angle measure and arc measure.	G.10		
	Find the area of a sector and the area of a segment of a circle.	G.10		

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Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources

Circles (continued)	Use the properties of angles, arcs, segments, and lines associated with circles to solve practical problems involving circles. Look at applications in art, construction, architecture, and the sciences.	G.10		• *Geometry Instructional Modules*
				  – Circumference p. 102
				  – Cake Problem p. 103
				  – Geometer's Sketchpad Investigation of J p. 105
				  – Problem Solving with Circles p. 108
				  – Investigation of Secants and Circles p. 113

Three-Dimensional Geometry	Use properties of three-dimensional objects to make models.	G.12	Individual quizzes Group quizzes Tests Projects Investigations Portfolios Student presentations Questioning strategies Peer evaluation	• Mathematics SOL Teacher Resource Guide http://www.pen.k12.va.us/VDOE/Instruction/math_resource.html • SOL Test Blueprints • SOL Test Released Items • The Geometry Center http://www.umn.edu/ • NASA http://spacelink.nasa.gov/.index.html • The Math Forum http://forum.swarthmore.edu/ • 4teachers http://www.4teachers.org
	Make a model of a three-dimensional figure from a two-dimensional drawing.	G.12		
	Make a two-dimensional representation of a three-dimensional object.	G.12		
	Use scale drawings, perspective drawings, blueprints, or computer drawings as models of three-dimensional objects to solve problems.	G.12		
	Identify a three-dimensional object from different positions such as the top view, side view, and front view.	G.12		

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Organizing Topic	Essential Knowledge and Skills	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Three-Dimensional Geometry (continued)	Use the appropriate formulas to find the surface area of cylinders, prisms, pyramids, cones, and spheres.	G.13		• Appalachia Educational Laboratory (AEL) http://www.ael.org/pnp/index.htm
	Use the appropriate formulas to calculate the volume of cylinders, prisms, pyramids, cones, and spheres.	G.13		• Eisenhower National Clearinghouse http://www.enc.org/
	Solve practical problems involving surface area and volume of cylinders, prisms, pyramids, cones, and spheres as well as combinations of three-dimensional figures.	G.13		• *Geometry Instructional Modules* – Spatial Problem Solving p. 129 – Architect's Square p. 130 – Comparing the Edge, Length, Surface Area, and Volume of Cubes p. 149
	Use proportions to compare surface area and volumes of three-dimensional geometric figures.	G.14		– Comparing the Radius. Surface Area, and Volume of Spheres p. 151 – Euler's Formula p. 116
	Describe how a change in one measure affects other measures of an object.	G.14		– Constructing the Soma Cube p. 117
	Solve practical problems involving similar objects.	G.14		– Making Two-Dimensional Drawings of Three-Dimensional Figures p. 127

Geometry Standards of Learning Sample Scope and Sequence

Additional Topics in Geometry	*These topics are not assessed on the Geometry end-of-course assessment, but they may be used to enhance knowledge of some topics in Geometry and to bring closure to the course.* Prove with constructions and coordinate methods: • If a point is on the perpendicular bisector of a segment, then it is equidistant from the endpoints of the segment. • If a point is equidistant from the endpoints of a segment, then it lies on the perpendicular bisector of the segment. Investigate concurrency properties in triangles through paper folding, and form a conjecture. Perform and prove the concurrency constructions using only a straightedge and compass. • angle bisectors and the incenter of the triangle • perpendicular bisectors of the sides of the triangle and the circumcenter of the triangle • medians from each vertex of the triangle and the centroid of the triangle • altitudes to each side of the triangle from the opposing vertex and the orthocenter of the triangle.			